# DESTRUCTION OF YOUNG COLONIES OF THE RED IMPORTED FIRE ANT BY THE PAVEMENT ANT (HYMENOPTERA: FORMICIDAE)[1]

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ABSTRACT: The ranges of the red imported fire ant, *Solenopsis invicta*, and the pavement ant, *Tetramorium caespitum*, are now virtually contiguous in North Carolina, and these species have undoubtedly interacted. Our laboratory study shows that *T. caespitum* will destroy young *S. invicta* colonies placed within its foraging range. If *S. invicta* moves northward, interactions between these two species may intensify.

The pavement ant, *Tetramorium caespitum* (L.), and the red imported fire ant, *Solenopsis invicta* Buren, can both rapidly mobilize many workers to dominate large food sources. Often this attempt to dominate a resource results in conflict with other ant species which they eliminate or "extirpate" as the situation requires (Wilson, 1971). Interspecific conflicts between ant species resulting in numerous deaths rarely occur in temperate ecosystems (see MacKay and MacKay 1982 for exceptions), but can occur when more than one extirpating species cohabit in an ecosystem. These conflicts occurred when *S. invicta*, a native of South America, was introduced into Alabama in the 1940's (Hung and Vinson, 1978). It has since spread across most of the southern U.S.A., eliminating the native, dominant species from much of their former range. At present, territorial limits of *S. invicta* in North America are largely defined by abiotic factors, namely cold weather in its northernmost range and arid conditions in its westernmost range (Hung and Vinson, 1978).

Bhatkar *et al.* (1972) suggested that the northward expansion of *S. invicta* may have been slowed or halted by the presence of *Lasius neoniger* Emery, an aggressive and populous northern ant species. They stated that *L. neoniger* colonies, although numbering less than 1000 ants, maintained between 8,000 and 10,000 nests per acre in two study areas. This density, coupled with the distinctly superior combative capabilities demonstrated against *S. invicta*, may allow this ant to successfully compete with *S. invicta*. If so, *L. neoniger* could be one of the agents of

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indigenous biological control restricting the range of *S. invicta* in North America.

*T. caespitum* occurs throughout much of the Holarctic and Ethiopian faunal realms and has been reported on every continent except Antarctica (Creighton, 1950). In much of its extensive range, it maintains a prominent role, often sharing that position with *L. neoniger* in the Nearctic, and *L. niger* (L.) and *L. alienus* Forster in the Palearctic (Brian and Elmes, 1974; Creighton, 1950). Presently, the North American range of *T. caespitum* includes the Atlantic Coast south to North Carolina, and sporadic and occasionally extensive regions west to California (Creighton, 1950; Nuhn and Wright, 1980). In the Palearctic, *T. caespitum* lives in open areas, scavenging for insects and collecting seeds (Brian *et al.,* 1967; Brown, 1957; Smith, 1943). In the Nearctic, the species is usually confined to areas near human habitations (Brown, 1957; Creighton, 1950).

The present ranges of *T. caespitum* and *S. invicta* are now contiguous in North Carolina, and the assumption that some contact has occurred between these two highly successful species is not unreasonable. Contact should continue to occur because the potentially northernmost range of *S. invicta* (Pimm and Bartell, 1980) overlaps with the southernmost range of *T. caespitum* (T.G.K., personal observation). The present laboratory study describes the reaction of *T. caespitum* to repeated introductions of both young colonies and single foundress queens of *S. invicta* placed within its foraging range. Although the final results obtained from the interaction of *T. caespitum* and *S. invicta* are restricted to conditions imposed by a controlled environment, the actual responses observed resulting from the forced interactions should simulate normal behaviors of *T. caespitum* to repeated incursions by *S. invicta* under more natural conditions.

## MATERIALS AND METHODS

A colony of approximately 15 workers and one queen of *T. caespitum*, collected in late summer of 1988 from Bucks County, Pennsylvania, was reared in an artificial nest placed within a four square meter, Fluon-coated plastic enclosure. The ants were fed insects and sugar water (50% sucrose), supplied with a source of free water, and kept at a temperature of approximately 25°C. After six months, the colony numbered more than 2,000 workers. Polygyne colonies (two or more queens per colony) of *S. invicta* from Kerr County, Texas, were collected in early spring of 1989 and divided into six sub-colonies, each containing two queens, between 100 and 200 workers, and brood. Test tube nests were used to house the sub-colonies. All artificial nests were constructed according to Banks *et al.* (1981). Once daily for three days, a sub-colony was placed 20 cm from the mature *T. caespitum* nest within the four square meter enclosure, and the sequence and timing of the sub-colony's destruction were recorded. Subsequently, the three other sub-colonies were introduced sequentially as previously described, but this time at one meter distances. Finally, three *S. invicta* queens were placed within the foraging area, and interspecific interactions were observed and recorded.

## RESULTS

When the *S. invicta* sub-colonies were placed 20 cm from the *T. caespitum* nest, several *S. invicta* workers made contact with *T. caespitum* foragers within one minute. *S. invicta* attacked *T. caespitum* during this initial contact, grasping them with their mandibles and repeatedly stinging the foreign workers. Curiously, individual *T. caespitum* workers rarely engaged *S. invicta* workers unless supported by nestmates, often waiting for additional workers to arrive before advancing toward the *S. invicta* nest. These supporting *T. caespitum* workers arrived within 10 minutes. Isolated *T. caespitum* workers that became surrounded by *S. invicta* usually ceased their movement and subsequently retreated to an area where *T. caespitum* formed a sizeable majority. Due to this technique, *T. caespitum* approached the *S. invicta* nest as a mass of approximately 100 workers slowly moving toward the source of aggression. *S. invicta* workers that entered the mass of approaching *T. caespitum* were captured by single *T. caespitum* workers that grabbed one of the *S. invicta* worker's appendages. Other *T. caespitum* workers then grabbed other appendages, pulling in opposite directions and causing the severing of the seized appendages. The *T. caespitum* workers would also sting, but the sting appeared to have little effect on the *S. invicta* workers.

Between five minutes and one-half hour passed before *T. caespitum* had incapacitated all *S. invicta* workers in the foraging area and began entering the *S. invicta* nest. When encountering the test tube nest, *T. caespitum* workers lunged inward, attempting to grab the gasterflagging *S. invicta* workers at the nest entrance. Gasterflagging, a process of spraying venom on enemies, caused *T. caespitum* to spasm for approximately 10 seconds before returning to normal. If a *T. caespitum* worker succeeded in grabbing a *S. invicta* worker, it would quickly withdraw, dragging the *S. invicta* worker into the mass of *T. caespitum* where it would be dismembered. In this slow fashion, *T. caespitum* pulled *S. invicta* workers, one at a time, out of their nest to be killed by the mass of beleaguered *T. caespitum.* The *T. caespitum* progression into the *S. invicta* nest continued until all *S. invicta* were dead. The captured *S. invicta* brood were taken back to the *T. caespitum* nest, presumably to be eaten.

When *S. invicta* nests were placed one meter from the *T. caespitum* colony, the sequence was the same but required more time. Contact between the species occurred within 2 minutes, and more than 10 *T. caespitum* workers gathered within 15 minutes to attack the *S. invicta* aggressors. More *S. invicta* workers had time to leave the nest; and as a result, the *T. caespitum* workers took longer to encircle the *S. invicta* nest site. Also, the *S. invicta* colony was able to escape to a new location shortly after *T. caespitum* workers began penetrating its nest. This reaction prolonged the conflict, since approximately 15 minutes passed before *T. caespitum* discovered the *S. invicta* colony's new nesting site. The rediscovery of the *S. invicta* colony resulted in a second atack, following which *S. invicta* scattered. Within one day, all *S. invicta* were killed. *T. caespitum* suffered less than two dozen fatalities per trial, with death resulting primarily due to numerous *S. invicta* stings.

A single queen of *S. invicta* was capable of killing a *T. caespitum* worker. Actual capture of *S. invicta* queens therefore required several *T. caespitum* workers acting together, pulling at the queen's appendages and stinging repeatedly. None of the *S. invicta* queens were captured after 10 minutes, but all were killed within 24 hours.

## DISCUSSION

The ranges of *T. caespitum* and *S. invicta* are now contiguous in North Carolina, and the two species have probably encountered one another. This study shows that *T. caespitum* may have the potential of delaying expansion of *S. invicta.* In North American the success of *T. caespitum* has been limited primarily to human inhabited areas.These areas already occupy large portions of the Atlantic seaboard and continue to gain in size.

*T. caespitum* is extremely territorial, a trait evidenced by frequent conspecific wars (Wilson, 1971; Brian *et al.,* 1966). As a result, destruction of the young *S. invicta* colonies by *T. caespitum* was expected. Not expected was the efficiency of attack by *T. caespitum* because more than five *S. invicta* workers died for every *T. caespitum* worker killed. The success of the *T. caespitum* attack depended on cooperation between workers and the ability to maintain a homogeneous mass of attacking workers within which *S. invicta* workers would be dismembered. In England, these skillful attack methods enable *T. caespitum* to "rout" large colonies of *L. alienus*, and defeat colonies of *L. niger* (Brian *et al.*, 1966).

Colonies of *T. caespitum* contain an average of approximately 10,000 workers (Brian, 1979); whereas mature *S. invicta* colonies maintain in excess of 60,000 workers (Tschinkel, 1986). Conflicts between mature colonies, therefore, could result in *S. invicta* overwhelming *T. caespitum*. Colder temperatures retard colony growth in laboratory colonies of *S. invicta* (Porter, 1988); and as a result, the average colony size of *S. invicta* and *T. caespitum* may be more comparable in the northernmost range of *S. invicta*. If not, *T. caespitum* may dominate its habitat only if it destroys young *S. invicta* colonies in the field as it did in the laboratory.

Our study simply identifies one potential biotic factor which may impose mortality on *S. invicta*. However, the results we obtained (destruction of *S. invicta*) are limited to conditions inherent in laboratory studies of this type. Therefore, although the responses of *T. caespitum* to *S. invicta* are accurate, caution should be exercised regarding the effectiveness of *T. caespitum* as a controlling agent until field studies are conducted to substantiate our laboratory findings.

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## CALVERT AWARDS FOR 1991 AND 1992

In 1987 the American Entomological Society initiated the Calvert Award to be presented annually to a young person in the greater Delaware Valley for an outstanding insect-related project. The Award was named in honor of Dr. Philip P. Calvert who joined the Society as a teenager, later became its president, and was a member for 74 years. As a professor of biology at the University of Pennsylvania and an associate of the Academy of Natural Sciences of Philadelphia, Dr. Calvert played an important role in stimulating an interest in insects among young people.

This year the Calvert Award was presented to Amy Dorfman, a tenth grade student at Central High School in Philadelphia—the same school from which Calvert graduated in 1888! Her project was entitled, "Farnesol vs. Natural Predation: Will the Benefits of a Larvacide Outweigh the Advantages of Interaction in a Food Chain?" President Joseph Sheldon presented Miss Dorfman with one-year memberships in the American Entomological Society and the Young Entomologists' Society, a one-year subscription to *Entomological News,* and a check for $50. Amy's project and those of three other students at the Delaware Valley Science Fairs were displayed at the April 22 membership meeting at the Academy of Natural Sciences.

First runner-up was Dawn Riddle, a ninth grade student also from Central High School, whose project was on, "The Effects of Chemicals on the Pheromone Trails of Ants." Two honorable mentions were awarded, both to juniors from Ocean Township High School, Oakhurst, New Jersey. Gisela Insvaste studied the "Effect of Protozoan *Lambornella clarki* on Larval Populations of the Mosquito *Aedes aegypti* in the Laboratory" and Denis Shmuler made a "Comparison of Stem and Leaf Growth of European Violets Germinated in Harvester Ant Nests."

Last year Amy Dorfman's project was first runner-up to that of Helen Glezos, then a sophomore at Woodstown High School, Woodstown, New Jersey, who addressed the question, "Does Captive Feeding Increase the Growth and Life Span of the Praying Mantis?" Second runner-up in 1991 was presented to Kevin Bonner, a ninth grade student at Archbishop Wood High School, Warminster, Pennsylvania. He studied "Substance Preference among Carpenter Ants." The awards were presented on April 24 at a Society meeting featuring Dr. Thomas Donnelly, a particularly appropriate guest speaker. Dr. Donnelly had met Philip P. Calvert through their mutual interest in dragonflies. At the beginning of his talk he related some of his memories of Dr. Calvert.

Harold B. White